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Life history of *Oidaematophorus hirosakianus* (Matsumura) (Lepidoptera: Pterophoridae)

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Abstract Life history of *Oidaematophorus hirosakianus* (Matsumura), the most common plume-moth in Japan, was studied both from fundamental and applied viewpoints. Number of larval instars, seasonal abundance, nest making and structure as well as developmental data were described.

Key words *Oidaematophorus hirosakianus*, Pterophoridae, *Artemisia princeps*, life history.

Introduction

Oidaematophorus hirosakianus (Matsumura) (Japanese name: Yomogi-toriba) is commonly seen along roadsides or on fallow land in Japan and larvae feed on a common *Artemisia* species, *A. princeps* Pampan forming tent-like nests. Adults and earlier stages of this species in Japan were described by Yano (1963) under the name of *O. lienigianus* (Zeller), but other biological data have not been presented till now. The reason we use *O. hirosakianus* in this paper is referable to Yano *et al.* (1996).

The host plant, *A. princeps*, has been used as a food and for medical purposes in Japan. It has another status, however, being a rather dominant and even serious weed in orchards and mulberry fields (Numata and Yoshizawa, 1975). Information on the biology of this plume-moth is thus of value from this applied standpoint as well as for taxonomic studies.

Oidaematophorus Wallengren is a large genus comprising about ten species in Japan. Some among them such as *O. ishiyamanus* (Matsumura), *O. albidactylus* Yano, *O. acutus* Yano and others including undescribed species in Japan are closely allied to *O. hirosakianus*. The detailed morphology and biology of the earlier stages of these species have been eagerly awaited to understand their taxonomic status.

This study was undertaken to satisfy both this fundamental and applied need.

Materials and methods

Field surveys were made on Yamaguchi University Farm, Yamaguchi City and neighboring areas from April to December, 1994, and rearing was done in the laboratory at different temperatures.

Rearings

Larvae were reared in petri dishes (90 mm in diameter, 45 mm in height) or vials (35 mm in diameter, 77 mm in height). Fresh leaves of *Artemisia princeps* were given every two or three days. Pupae were kept in vials until emergence. Emerged adults were reared in petri dishes (100 mm in diameter, 80 mm in height) with host plant leaves for oviposi-

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tion. One pair of adults was reared in each of six plots to observe oviposition with or without honey.

Morphological studies

Larvae reared at 25°C were randomly removed and preserved in alcohol to measure head width for determination of larval instars. To investigate the ovarian eggs, pupae were reared individually. Emerged adults were reared on water or diluted honey for several days, and then preserved in alcohol for dissection of the abdomen.

Developmental studies

Developmental rate, developmental zero and total effective temperatures were calculated based on the material reared at 20°C, 25°C, 28°C and 30°C with a photoperiod 16L : 8D.

Seasonal abundance

Regular collections of larvae in the fields were made from April 5 to December 21, 1994 at 10 day intervals to detect seasonal abundance. Shape and size of nests were measured, and larvae were preserved in alcohol for later measurements of head width to determine their instars.

Results and discussion

1. Eggs

Eggs were elliptical and pale yellowish, and were usually laid singly on the under surfaces of leaves. Oviposition on the upper surfaces of leaves or petioles was rare in the laboratory and was never found in the fields. Egg measurements are shown in Table 1. The eggs of this species are slightly smaller than those of *O. beneficus* Yano et Heppner (Yano and Heppner, 1983).

2. Larval instars

Frequency distribution of head width of the field (665 larvae) and reared (369 larvae) populations is shown in Fig. 1. Five peaks are recognized in both populations indicating five larval instars.

The larval instars of some plume-moths were known. So far as we are aware, those species reported had four larval instars (Lange, 1950 ; Parrella and Kok, 1978 ; Bari and Lange, 1980 ; Cassani *et al.*, 1990). These authors determined the instars by head width measurements, but did not present its original values or figures, though Parrella and Kok (1978) showed mean value of each instar without individual data. Since the values of

Table 1. Measurements of eggs of *Oidaematophorus hirosakianus*[1].

	No. eggs	Measurements (mm)		Mean±SD
		Min.	Max.	
Length	12	0.335	0.382	0.358±0.0131
Width	12	0.240	0.263	0.254±0.0069
Height	12	0.160	0.196	0.175±0.0117

[1] Reared at 25°C.

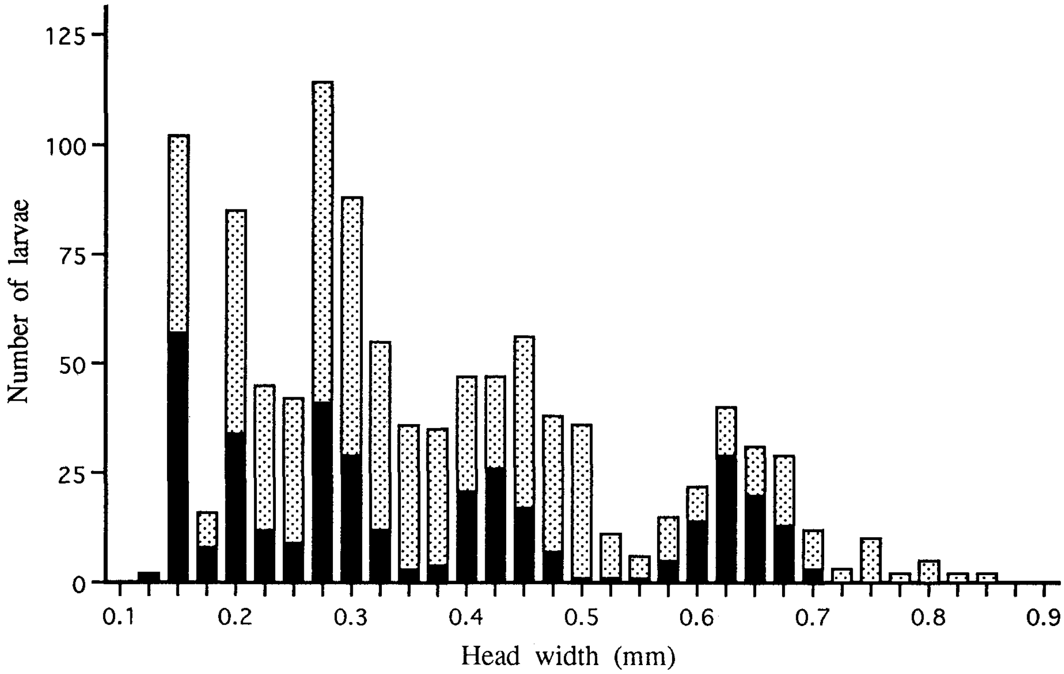

Fig. 1. Frequency distribution of head width of *Oidaematophorus hirosakianus* larvae (stippled : field population, solid shading : reared population).

head width of the 1st and 2nd instar larvae of this family are very small and are not distinctly different as shown in Fig. 1, we have a doubt whether these species reported have four instars or not.

Two more data should be mentioned here. Chapman (1906) mentioned that the larva of *Trichoptilus paludum* seemed to have four instars without data. Suzuki (1982, unpublished) mentioned the five larval instars for *Platyptilia farfarella* based on the head width measurements.

As frequency distribution of the head width obtained in this study is considered empirically normal distribution, the range, its means and standard deviation of each instar were statistically measured. This provided the range of head width of each instar (Table 2).

Table 2 shows little difference between rearing and field populations. This may be due to changing temperatures in the field compared with the uniform one (25°C) in the laboratory as reported earlier in other species of Lepidoptera (Hirata *et al.*, 1967 ; Kitano, 1967 ; Matsumoto and Yano, 1995). As mean head width between reared and field populations in each instar is not significantly different ($p<0.05$), measurements of the two populations are combined in this table. Though the statistical treatments are artificial, these figures on larval instars are used in the following studies to differentiate instars.

3. Seasonal abundance

Percentages of individual numbers of each instar collected by regular samplings are shown in Fig. 2. Peaks of the 5th instar and the 3rd and 4th instars appeared in early April and late December, respectively suggesting overwintering in probably the 3rd or 4th instar larvae.

Since samplings in March and early April were inadequate, it is difficult to determine

Table 2. Head width of *Oidaematophorus hirosakianus* larvae.

Instar	No. larvae	Range (mm)	Mean (mm)	SD (mm)	CV (%)	Growth ratio
A. Reared population (25°C)						
I	59	0.125-0.174	0.156	0.0040	2.56	1.36
II	54	0.175-0.249	0.212	0.0148	6.98	1.42
II	94	0.250-0.374	0.301	0.0233	7.74	1.46
IV	77	0.375-0.549	0.440	0.0292	6.64	1.47
V	85	0.550-0.724	0.648	0.0310	4.78	
B. Field population						
I	45	0.150-0.174	0.157	0.0039	2.48	1.38
II	92	0.175-0.249	0.217	0.0152	7.00	1.50
III	298	0.250-0.424	0.326	0.0460	14.11	1.48
IV	136	0.425-0.549	0.484	0.0306	6.32	1.42
V	94	0.550-0.874	0.686	0.0736	10.73	
C. Reared and field populations						
I	104	0.150-0.174	0.157	0.0040	2.55	1.37
II	146	0.175-0.249	0.215	0.0152	7.07	1.42
III	335	0.250-0.374	0.306	0.0292	9.54	1.48
IV	270	0.375-0.549	0.454	0.0435	9.58	1.47
V	179	0.550-0.874	0.668	0.0603	9.03	

which peaks are the first generation or not. Judging from the occurrence of the 5th instar larvae in April and May, however, the first peak of the 3rd instar larvae and those which follow are believed to be the first generation. The following evaluations are based on this criterion.

The 2nd generation, then, seems to appear from early May (1st instar larvae) to June (peak of pupae was found in late June). The 3rd generation appears from late June (1st instar larvae) to August (5th instar larvae). The 4th generation appears from late August (1st and 2nd instar larvae) to mid-September (5th instar larvae). The 5th generation may be from mid-September (1st and 2nd instar larvae) to mid-October (4th instar larvae). No peak of the 5th instar larvae of the 5th generation was seen, and this probably appears in mid- or late October. The 6th or overwintering generation is from early October (1st instar larvae) to late November (4th instar larvae) and overwintering in the 3rd or 4th instar larvae is suspected as mentioned.

Though these samplings suggest that there are five or six generations a year, this is discussed again in the following pages on developmental data.

4. Nests

1) Nest making

Nest making of each instar larva is shown in Table 3 based on the field-collected material. The 1st instar larvae do not make nests nor do those following instar larvae at a rate of about 13 to 67% depending on the instar. As larvae other than the 1st instar move from their nests, especially the 5th instar larvae which pupate outside nests, the percentage of nest making may include those of larvae which leave the nests.

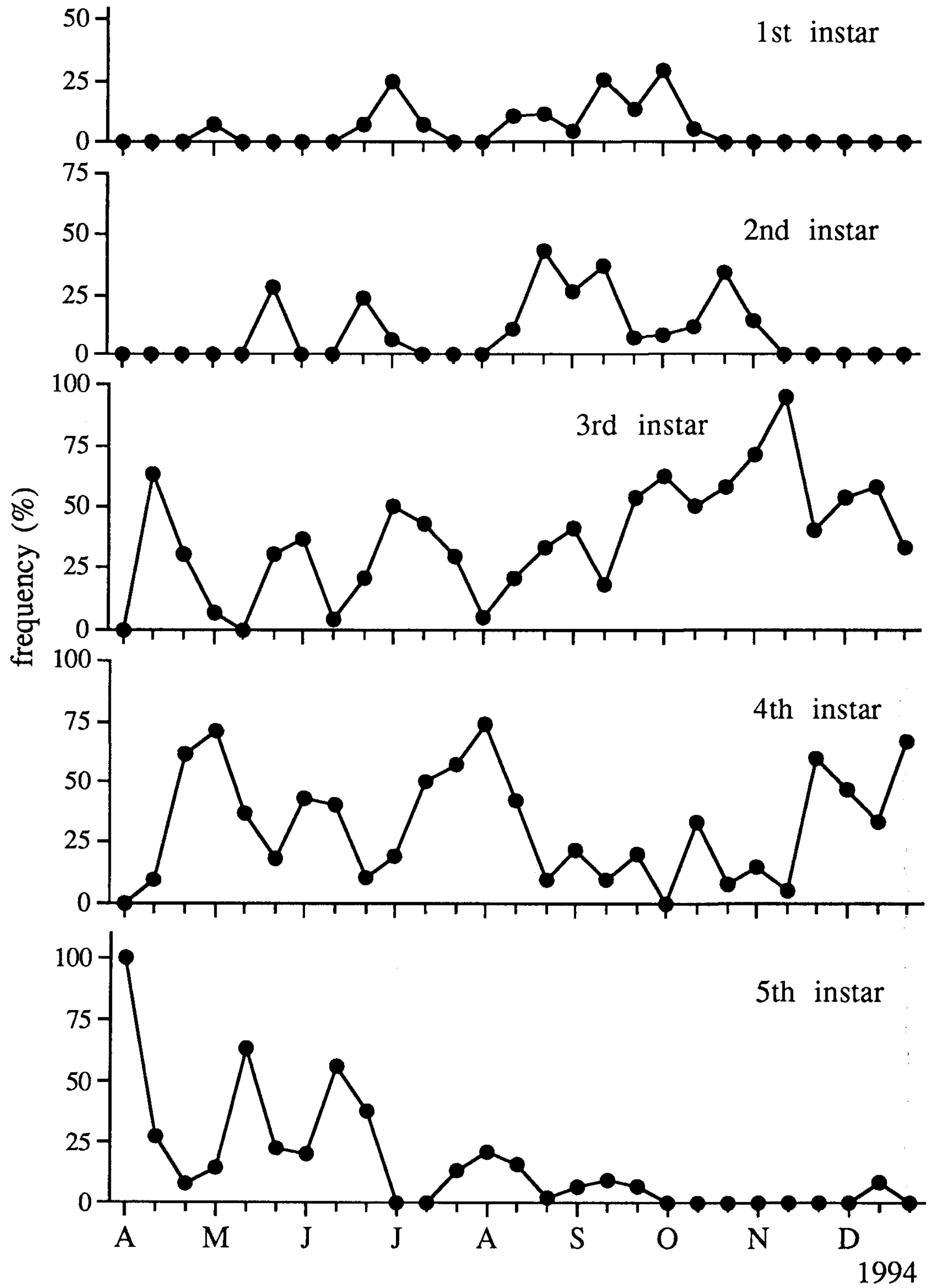

Fig. 2. Seasonal abundance of *Oidaematophorus hirosakianus* larvae based on field samplings (Yamaguchi City, 1994).

Pupation usually took place outside nests, and four pupae were found on leaves other than those of the nests.

2) Nest structure

The leaf of *A. princeps* has deep clefts forming 3 or 7 leaflet-like parts. These parts are referable to as leaflets in the following lines. The larvae fold the leaflets and form a sort of tent (with the upper surface of the leaf outward) and eat the folded leaf from the inside, the upper epidermis being left untouched. Number of leaflets used for nests is shown in Table 4 and increases as larval instars. Table 4 shows that 2nd instar larvae

Table 3. Nest making of *Oidaematophorus hirosakianus* larvae.[1)]

Instar	No. larvae	Without nest	With nest	% nest making
I	41	41	0	0
II	84	56	28	33.3
III	209	57	152	72.7
IV	184	38	146	79.3
V	91	12	79	86.8

[1)] Larvae collected in Yamaguchi City during April to December, 1994. Nests containing two or more larvae are excluded.

Table 4. Number of leaflets used by *Oidaematophorus hirosakianus* larvae for a nest[1)].

Instar	No. larvae	No. leaflets		Mean±SD
		Min.	Max.	
II	28	1	3	1.07±0.378
III	152	1	5	2.21±1.350
IV	146	1	5	2.39±1.435
V	79	1	5	2.89±1.463

[1)] Larvae collected in Yamaguchi City during April to December, 1994. Nests containing two or more larvae are excluded.

usually use 1 leaflet, while 3rd or later instars use 3.

3) Size of nests

Length and width of nests of each instar are shown in Figs 3 and 4. Common nests (nests shared by two or more larvae) are excluded in the data.

Length and width increase as instars, but ranges in the 3rd and 4th instar larvae are not different.

4) Common nests

Among 430 nests found in the fields, 21 were shared by two larvae, 2 by three larvae, and 2 by four larvae. The twenty-one nests shared by two larvae are shown in the matrix (Table 5), which also shows that the 3rd instar larvae are usually associated with those common nests (76%). The 1st instar larva was involved in only one example. One nest shared by four larvae contained three 1st instar larvae and one 2nd instar larva. In the latter case, three empty egg shells were found inside the nest suggesting the 2nd instar larva had made the nest where eggs had already laid on the leaf.

5. Number of ovarian eggs

Table 6 shows the number of ovarian eggs (mature oocytes) of unmated females fed water or honey for 5 days after emergence. Newly emerged females did not have many ovarian eggs, but the number increased as days progressed indicating synovigenic type of ovary. No significant difference was seen among those of 3 to 5 days, however.

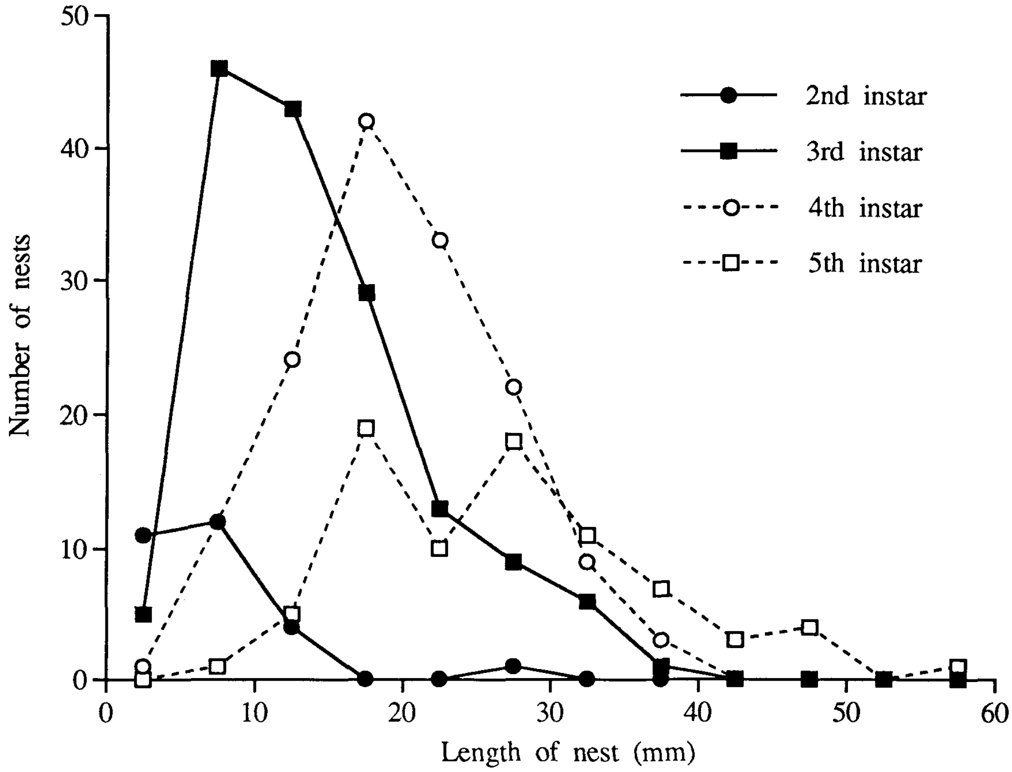

Fig. 3. Length of nests made by *Oidaematophorus hirosakianus* larvae (Yamaguchi City, 1994).

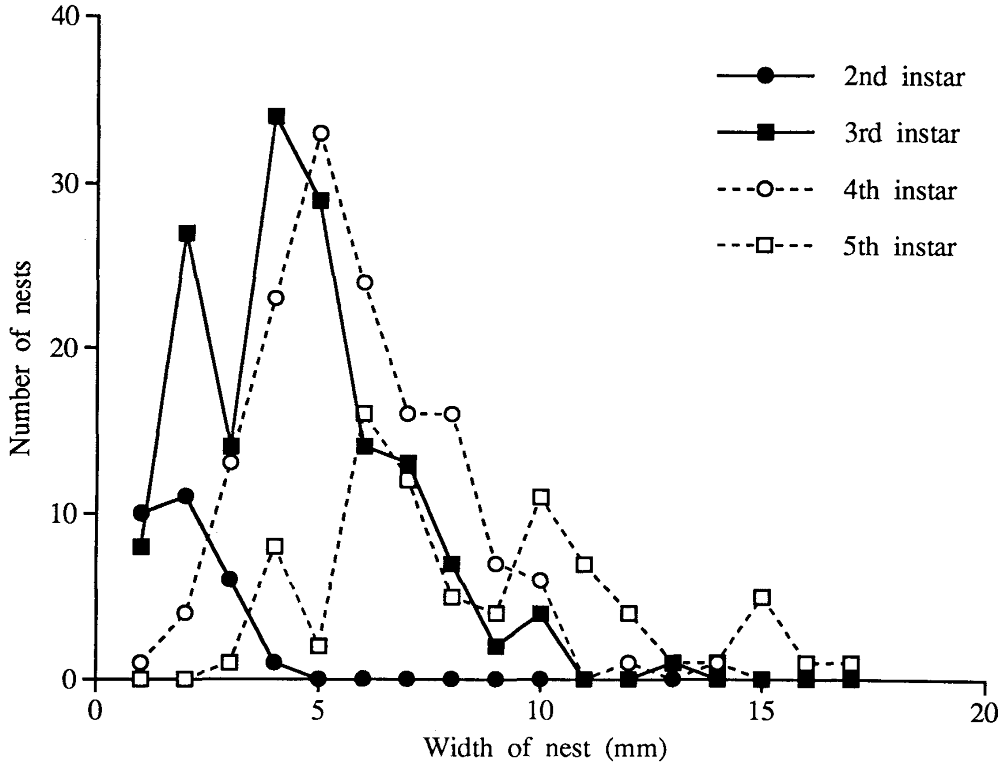

Fig. 4. Width of nests made by *Oidaematophorus hirosakianus* larvae (Yamaguchi City, 1994).

Table 5. Matrix of common nests of *Oidaematophorus hirosakianus* larvae[1].

Instar	I	II	III	IV	V
I	0	0	1	0	0
II	-	2	3	0	0
III	-	-	8	4	0
IV	-	-	-	1	2
V	-	-	-	-	0

[1] Larvae collected in Yamaguchi City from April to December, 1994.

Table 6. Number of ovarian eggs of unmated *Oidaematophorus hirosakianus*[1].

Days after emergence	No. adults	No. ovarian eggs		Mean±SD
		Min.	Max.	
A. Fed water				
1	27	1	59	21.5±15.74a
2	21	16	77	55.0±14.37b
3	23	44	99	72.4±15.48c
4	29	34	97	75.3±13.26c
5	20	22	101	72.4±22.67c
B. Fed honey				
1	-	-	-	-
2	20	36	81	53.5±11.10b
3	20	33	99	70.2±19.00c
4	11	32	89	66.4±16.77c
5	5	58	90	73.6±14.84c

[1] Reared at 25°C. Numbers in column followed by the same letter are not significantly different (Duncan's multiple range test: $p<0.05$)

Table 7. Number of eggs laid by *Oidaematophorus hirosakianus*[1].

Exp. plot	Days after start of rearing											Total
	1	2	3	4	5	6	7	8	9	9-10	11-13	
A	0	72	0	27	22	28	19	0	-	-	-	168
B	0	60	0	0	20	0	0	0	0	-	-	80
C	0	54	32	22	16	0	-	-	-	-	-	124
D	0	39	9	15	11	5	2	9	2	-	-	92
E	0	4	2	59	18	16	21	25	-	25	6	151
F	0	72	42	37	21	25	21	29	-	29	13	289

[1] One pair was reared in each plot. Honey was not fed in Exp. plots, A, B, C and D, but was fed in Exp. plots E and F. Experiments were done at 25°C.

Table 8. Developmental period of *Oidaematophorus hirosakianus*.

Develop. stage	Rearing temp.(°C)	No. reared	Develop. period		Mean±SD	Develop. rate
			Min.	Max.		
A. Both sexes						
Egg	20	34	8	8	8.0±0.000	0.125
	25	37	5	6	5.8±0.374	0.171
	28	18	5	7	5.1±0.471	0.196
Larva	20	34	24	34	27.4±2.241	0.0366
	25	37	16	23	19.2±1.937	0.0522
	28	18	15	23	19.3±2.029	0.0517
Pupa	20	35	10	11	10.2±0.406	0.0980
	25	37	6	7	7.0±0.164	0.143
	28	18	6	7	6.1±0.236	0.165
Egg-	20	35	42	52	44.5±2.241	0.0220
emerg.	25	37	29	36	32.0±1.951	0.0313
	28	18	26	34	30.5±2.007	0.0328
B. Males						
Egg	20	20	8	8	8.0±0.000	0.125
	25	21	5	6	5.9±0.301	0.169
	28	10	5	7	5.2±0.632	0.192
Larva	20	20	24	31	26.6±1.698	0.0376
	25	21	16	23	18.6±2.133	0.0357
	28	10	15	23	19.0±2.404	0.0526
Pupa	20	20	10	11	10.3±0.444	0.0976
	25	21	6	7	7.0±0.218	0.144
	28	10	6	6	6.0±0.000	0.167
Egg-	20	20	42	50	44.9±1.785	0.0223
emerg.	25	21	29	36	31.5±2.064	0.0318
	28	10	26	34	30.2±2.300	0.0331
C. Females						
Egg	20	14	8	8	8.0±0.000	0.125
	25	16	5	6	5.8±0.447	0.174
	28	8	5	5	5.0±0.000	0.200
Larva	20	14	25	34	28.4±2.533	0.0352
	25	16	18	23	19.9±1.408	0.0503
	28	8	18	22	19.8±1.488	0.0506
Pupa	20	15	10	11	10.1±0.352	0.0987
	25	16	7	7	7.0±0.000	0.143
	28	8	6	7	6.0±0.354	0.163
Egg-	20	15	43	52	46.3±2.554	0.0216
emerg.	25	16	30	36	32.6±1.628	0.0307
	28	8	29	33	30.6±1.642	0.0324

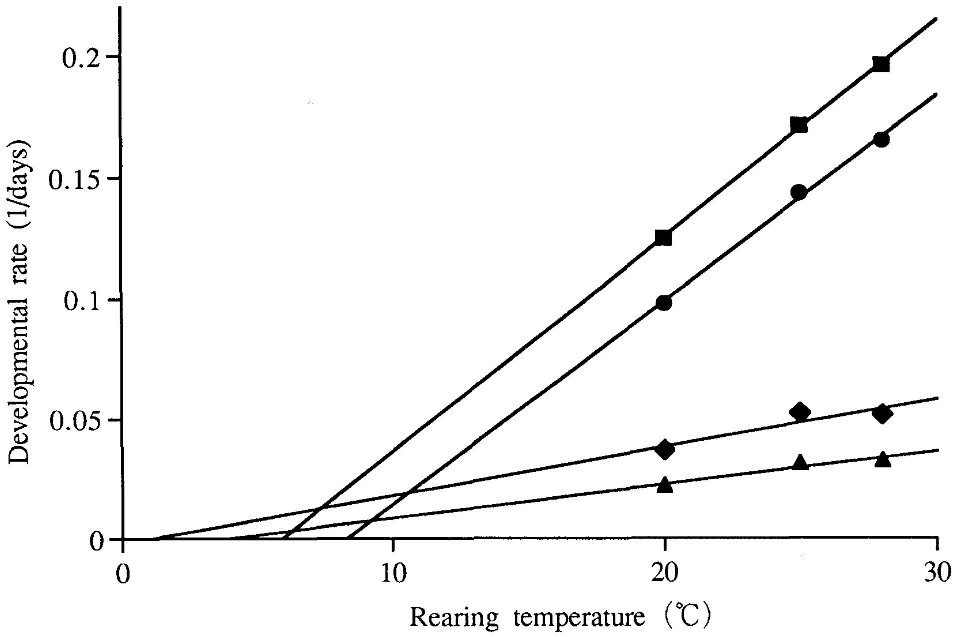

Fig. 5. Developmental rate of *Oidaematophorus hirosakianus* reared at different temperatures. ■: Egg ($y=0.0089x-0.0528$, $r=0.9997$). ◆: Larva ($y=0.0020x-0.0022$, $r=0.9177$). ●: Pupa ($y=0.0085x-0.0703$, $r=0.9983$). ▲: Egg-emergence ($y=0.0014x-0.0054$, $r=0.9685$).

6. Number of eggs laid

Number of eggs laid in the laboratory at 25°C is shown in Table 7. Four experiments (Plots A, B, C, D) were made with leaves of the host plant, and two (Plots E, F) with leaves and honey. No oviposition was seen in any of the plots on the first day, and the number was maximum on the second day in most cases. Number of eggs laid and longevity of females in the plots with honey increased more than those in the plots without honey. Total number of eggs laid per female was greater than those of eggs found by dissection at any time. A single female without a male reared with host plant lived for 6 days and did not oviposit.

Judging from the present result and some published records on the number of eggs laid (Hori, 1934; Lange, 1950; Parrella and Kok, 1978; Bari and Lange, 1980), females of plume-moths seem to oviposit between 100 and 300. The case of *Oidaematophorus monodactylus* presented by Mohyuddin (1969) reporting 478 eggs laid by a female may be exceptional.

7. Developmental period

Developmental period of each stage reared at different temperatures is shown in Table 8. Among more than 100 eggs reared at 30°C, only several eggs hatched. These larvae died within 2 or 3 days before reaching the 2nd instar. Last instar larvae, however, when reared at 30°C pupated and emerged. Thus maximum temperature for development of the younger instar larvae may be 29 or 30°C. This result is the same as that reported by Bari and Lange (1980) who mentioned that eggs of *Platyptilia carduidactyla* did not develop at 7°C and 30°C.

Periods obtained at 20, 25 and 28°C are shown in the table. Those of egg and pupal stages were not different between both sexes. Females required longer larval periods than males. Developmental periods decreased as temperature increased in both sexes,

Table 9. Developmental zero and total effective temperature for development of *Oidaematophorus hirosakianus*[1].

Develop. stage	Regression equation	r	Developmental zero	Total effective temperature (day-degrees)
A. Both sexes				
Egg	$y=0.0089x-0.0528$	1.000*	5.92	112.3
Larva	$y=0.0020x-0.0022$	0.918	1.07	496.7
Pupa	$y=0.0085x-0.0703$	0.998*	8.31	118.2
Egg-emerg.	$y=0.0014x-0.0054$	0.969	3.86	713.2
B. Males				
Egg	$y=0.0084x-0.0428$	0.999*	5.09	118.8
Larva	$y=0.0020x-0.0010$	0.904	0.50	497.0
Pupa	$y=0.0087x-0.0750$	0.999*	8.63	115.2
Egg-emerg.	$y=0.0014x-0.0052$	0.964	3.66	711.2
C. Females				
Egg	$y=0.0094x-0.0628$	1.000*	6.67	106.2
Larva	$y=0.0020x-0.0042$	0.935	2.06	491.0
Pupa	$y=0.0081x-0.0617$	0.998*	7.63	123.7
Egg-emerg.	$y=0.0014x-0.0058$	0.973	4.14	715.3

[1] Numbers with asterisk are significant ($p<0.05$).

but decreased slowly above 25°C.

8. Developmental rate, developmental zero and total effective temperature

Based on the data shown in Table 8, a regression equation and correlation coefficient (r) were calculated, and developmental zero and total effective temperatures were obtained (Fig. 5, Table 9). Developmental zero of larval stage was the lowest among all developmental stages, and the temperature (around 1 or 2°C) was much lower than in other insect species (Utida, 1957). Developmental zero through all stages was lower in males than in females. Developmental zero of larval stage obtained is inclusive of all instars. Those of younger instars may be much higher judging from the data of Bari and Lange (1980) concerning *Platyptilia carduidactyla*.

Total effective temperature obtained theoretically here does not include preoviposition period. Most pairs reared at 20 or 25°C in one rearing case mated and oviposited within 48 hrs. Total effective temperature of this species is consequently around 750 day-degrees. The value is greater than that of *Platyptilia carduidactyla* (*e. g.* Bari and Lange, 1980) which is the only record of the family so far as we are aware.

9. Number of generations

Based on the weather record in Yamaguchi City (daily mean temperature) and the preceding data (750 day-degrees for total effective temperature), number of generations a year of this species is figured as 5.95 indicating 5 or 6 generations a year in Yamaguchi

City. This supports the seasonal abundance shown by regular collectings of larvae (Fig. 2) and the related discussion above.

Beirne (1954) mentioned that adults of *Oidaematophorus lienigianus* in Britain appeared in only July. Since the species is closely allied to *O. hirosakianus*, decreased number of generations in Britain which is much higher in latitude than Yamaguchi is reasonable.

Published records on the number of generations of other plume-moths briefly mentioned one and two, rarely three to five generations a year except for tropical homodynamic species (Shiraki, 1934; Hori, 1934; Beirne, 1954; Buszko, 1985; Cassani *et al*., 1990). These numbers were estimated based on the occurrence of adults, but not by regular samplings or by experimental methods shown in the present study. The data obtained may be preferably compared with the future studies on other plume-moth species.

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摘　　要

ヨモギトリバ (鱗翅目：トリバガ科) の生活史 (神原叙子・矢野宏二)

日本で最も普通のヨモギトリバは，成虫と幼生期の形態は記載されているが (Yano, 1963)，生活史の詳細は不明であった．食草のヨモギは古くから食品の一部や医療用に使用されてきた一方で，雑草としても顕著である (沼田・吉沢，1975)．また，本種には未記載種を含めて近似種が多く，詳細な生物学的知見は，今後の本種群の分類学的研究にも必須であり，これら基礎，応用両面を視野に入れて本研究を実施した．

野外調査は山口市内で 1994 年 4 月から 12 月まで実施し，季節消長の調査は 10 日間隔で幼虫を採集した．飼育は恒温器を使用して温度別に行った．

1. 幼虫の齢数

野外個体群と飼育個体群 (25°C) の幼虫頭幅の頻度分布から，本種幼虫は 5 齢を経過すると判断した．この分布を経験的に正規分布とみなし，各齢頭幅の測定範囲，平均値，標準偏差を統計的に算出して，以下の調査項目における齢判定の基準とした．

2. 季節消長

定期調査による各齢幼虫の個体数割合から季節消長を判断した．12 月下旬の 3-4 齢幼虫と 4 月上旬の 5 齢幼虫のピークから判断して本種は 3 ないし 4 齢幼虫で越冬すると思われる．4 月と 5 月における 5 齢幼虫の発生状況から，3 齢幼虫の最初のピークが第 1 世代のものと判断すると，第 6 世代が 10 月上旬から 11 月下旬に発生し，越冬することになり，5 ないし 6 世代の発生と推定されるが，この点は下記の発育の項目で関連して検討する．

3. 幼虫の巣

1) 営巣．野外調査の結果，1 齢幼虫は営巣せず，2 齢，3 齢，4 齢，5 齢もそれぞれ 67%, 27%, 21%, 13% の個体が営巣していなかった．1 齢幼虫は飼育でも営巣しなかった．2 齢以後の幼虫は，巣を離れて移動することがあり，とくに 5 齢幼虫は巣外で蛹化するので，これらの移動個体が上記の巣なし個体数割合になっていると思われる．

2) 巣の形態．幼虫の巣は 1 ないし 5 枚の小葉 (ヨモギの葉は深く裂け，3 ないし 7 個の小葉状に分かれるので，その部分を便宜上小葉と表現する) をテント状に形成するが，齢の進行に伴って使用小葉数は増加した．

3) 巣の大きさ．巣の長さと幅を基準として測定すると，齢の進行に伴い，巣は大きくなった．

4) 共有巣．野外で採集した 430 個の巣のうち，21 個が 2 個体の幼虫，2 個が 3 個体，2 個が 4 個体の幼虫が入っていた．3 齢幼虫がこれら共有巣に関係することが最も多かった．1 齢幼虫と 3 齢幼虫が共有していたのが 1 例，1 齢幼虫 3 個体と 2 齢幼虫 1 個体の共有が 1 例見出された．後者の場合，空の卵殻が 3 個あったので，2 齢幼虫が産卵された葉を使用して営巣したものと判断される．1 齢は営巣しないので，いずれにしろ受動的な共有である．

4. 蔵卵数と産卵数

未交尾雌の蔵卵数を羽化後5日間にわたり調査した結果，羽化当日は少なく，2日目から5日目にかけて平均55-75卵を示し，最大値は101卵であった．3日目から5日目の間では有意差がなかった．

雄雌1組で飼育して産卵数を調査した結果，1日目は産卵せず，ハチミツを供餌しない区では2日目から9日目にかけて，供餌区では2日目から13日目にかけて産卵が見られ，合計80-168卵(非供餌区)と151-289卵(供餌区)の産卵があった．逐次発育型卵巣であるため，蔵卵数より多い数値を示した．

5. 発育所要期間

若齢幼虫の発育上限温度は29°Cないし30°Cであったが，5齢幼虫は30°Cでも蛹化，羽化した．20°C，25°C, 28°Cの温度における卵，幼虫，蛹，卵-羽化の各発育段階別の発育所要日数を求めた結果，25°Cでは卵から羽化までに31.5日(雄)と32.6日(雌)であった．

6. 発育速度，発育零点，有効積算温度

発育速度と飼育温度から回帰直線式と相関係数を求め，理論的発育零点と有効積算温度を算出した．卵-羽化期間の発育零点は雄で3.66°C，雌で4.14°C，幼虫は雄で0.50°C，雌で2.06°Cであり，鱗翅類の中でも低い方であった．雄雌一緒にした有効積算温度は713.2日度であった．本種は20-25°Cで羽化後48時間以内に交尾・産卵したので，1世代あたりの有効積算温度は750日度前後と思われる．

7. 世代数

平均気温法により山口の年間有効積算温度を求めると4,466.1日度であり，上記の理論的有効積算温度で算出すると，年間発生可能世代数は5.95回となった．したがって本種は山口市で5ないし6回発生すると推定され，前記の野外調査による季節消長の解析と一致した．

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